

# A New Species of *Japalura* (Squamata: Sauria: Agamidae) from Upper Lancang (Mekong) Valley of Eastern Tibet, China

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**Abstract** A new species of the agamid genus *Japalura* is described based on 15 specimens from the upper Lancang (Mekong) Valley of eastern Tibet, PR China. Populations of the new species, *Japalura vela* sp. nov., were previously recognized as *J. flaviceps*. The new species is morphologically most similar to *J. batangensis*, *J. micangshanensis*, *J. variegata*, and *J. zhaoermii*, but is distinguished from the four species and all remaining congeners by the following combination of morphological characters: 1) small adult size (SVL 56–69 mm in males, 59–66 mm in females); 2) ratio of tail TAL/SVL 1.85–2.06; 3) ratio of hind limb HLL/SVL 0.72–0.81; 4) T4S 24 or 25; 5) concealed tympanum; 6) transverse gular fold present; 7) gular pouch present; 8) axillary fold present; 9) a pronounced, continuous, sail-like vertebral crest along length of body in males; 10) ground dorsal coloration black in males; 11) distinct gray transverse streaks on dorsal surface of head; 12) black radiated streaks around eyes; 13) distinct, black vermiculate stripes on ventral surface of head in both sexes; 14) a strongly jagged dorsolateral stripe from neck to base of tail on each side of vertebral crest in males; and 15) absence of gular spots in both sexes. General distribution patterns of the genus in the Hengduan Mountains region are also discussed.

**Keywords** distribution, Hengduan Mountains, *Japalura*, *J. flaviceps*, species complex

## 1. Introduction

The agamid lizards of the genus *Japalura* Gray, 1853 are widely distributed in Asia from northwest India eastward to Japan. Currently, the genus contains 28 recognized species (Manthey *et al.*, 2012; Uetz and Hošek, 2014), with 14 of them recorded in mainland China: *J. andersoniana* Annandale, 1905; *J. batangensis* Li *et al.*, 2001; *J. brevicauda* Manthey *et al.*, 2012; *J. dymondi* (Boulenger, 1906); *J. fasciata* Mertens, 1926; *J. flaviceps* Barbour and Dunn, 1919; *J. grahami* (Stejneger, 1924); *J. kumaonensis* (Annandale, 1907); *J. micangshanensis*

Song, 1987; *J. splendida* Barbour and Dunn, 1919; *J. varcoae* (Boulenger, 1918), *J. yulongensis* Manthey *et al.*, 2012; *J. yunnanensis* Anderson, 1878; and *J. zhaoermii* Gao and Hou, 2002.

Among these species found in Mainland China, *J. flaviceps* was reported from Chamdo (=Changdu) and Markam (=Mangkang) of Chamdo Prefecture in eastern Tibet (Hu *et al.*, 1987; Li *et al.*, 2010; Pope, 1935; Zhao and Jiang, 1977). However, because later examinations of historically collected specimens of *Japalura* restricted the distribution of *J. flaviceps* to the Dadu River Valley only (Gao and Peng, 2005; Manthey *et al.*, 2012), and since Manthey *et al.* (2012) stated that the previously identified specimen of *J. flaviceps* from the upper Lancang (=Mekong) River at Jerkalo (=Yanjing) of Tibet may represent an undescribed species, the taxonomic statuses of Tibetan populations of *J. flaviceps* are questionable.

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During a herpetofaunal survey of Tibet in 2013, we collected 15 specimens of lizards identified to the genus *Japalura* from the upper Lancang Valley at Quzika (near Jerkalo) of the Chamdo Prefecture. In addition to a number of morphometric differences, these specimens can be distinguished easily from *J. flaviceps* by the presence of distinct radial streaks of pigmentation around the eyes. Following robust morphological comparisons, this population could not be assigned to any known congener. Therefore, we describe this lineage as a new species of *Japalura* and comment on the unique geographic distributions of members of the genus in the Hengduan Mountain regions.

## 2. Materials and Methods

All together 15 specimens of the new species were collected from the upper Lancang Valley at Quzika, eastern Tibet of China, including 10 adult males, two adult females, and three juveniles. After euthanasia, tissue samples were taken from the liver and preserved in 95% ethanol, and the voucher specimens were fixed in 10% buffered formalin and transferred to 70% ethanol after fieldwork. With the exception of a single male possessing an incomplete tail (KIZ013798), the remaining 11 adult specimens were designated as the type series. All specimens were deposited in the museum of the Kunming Institute of Zoology, Chinese Academy of Sciences.

We measured morphological characters with a slide caliper to the nearest 0.1 mm, except for the snout-vent length (SVL) and tail length (TAL), which were measured by a ruler to the nearest 1 mm, following the definitions of Ota (1989). The following abbreviations of morphological characters were used: snout-vent length (SVL), tail length (TAL), head length (HL), head width (HW), snout-eye length (SEL), orbital radius (OR), interorbital distance (IOD), fore-limb length (FLL), hind limb length (HLL), supralabial number (SL), infralabial number (IL), subdigital lamellae number beneath Toe IV (T4S), and mid-dorsal crest scale number, (MD). In addition to these morphological characters, the following morphometric characters were also examined: nasal-first supralabial scale count (NSL), scale number between the nasal and the first supralabial (NSL); supraciliary count (SCL), elongated and overlapping scale number in a continuous series from the posterior dorsal boundary of the nasal to the point in line with the posterior margin of the orbit; and supralabial-orbit scale row count (SOR), number of horizontal scale rows between the sixth supralabial and granular scales of the orbit right below the eye; length of

Toe IV (T4L), measured from the base of Toe IV to its tip, excluding the claw; trunk length (TRL), measured from the posterior insertion of fore-limbs to the anterior insertion of hind limb. Values of paired characters from both sides of the body are given in left/right order.

Voucher specimens of mainland species of *Japalura* were examined (Appendix 1), including *J. batangensis*, *J. dymondi*, *J. flaviceps*, *J. grahami*, *J. micangshanensis*, *J. splendida*, *J. varcoae*, *J. yunnanensis*, and *J. zhaoermii*. In addition, data of the following ten species were also obtained from Manthey *et al.* (2012): *J. andersoniana*, *J. brevicauda*, *J. chapaensis*, *J. fasciata*, *J. hamptoni*, *J. otai*, *J. planidorsata*, *J. sagittifera*, *J. variegata*, and *J. yulongensis*. Morphometric data of the following nine species were obtained from additional studies: *J. brevipes* (Ota, 1989b), *J. batangensis* (Li *et al.*, 2001; Wu *et al.*, 2004), *J. kumaonensis* (Schleich and Kästle, 2002), *J. luei* (Ota *et al.*, 1998), *J. makii* (Ota, 1989a), *J. swinhonis* (Ota, 1989b), *J. tricarinata* (Schleich and Kästle, 2002), and *J. zhaoermii* (Gao and Hou, 2002). Coloration data of live individuals of known *Japalura* species was obtained from primary literatures listed above or published books (Manthey, 2010; Schleich and Kästle, 2002; Yang and Rao, 2008; Zhao *et al.*, 1999). The museum abbreviations referenced in this study include: Smithsonian National Museum of Natural History (NMNH), Chengdu Institute of Biology, Chinese Academy of Sciences (CIB), Kunming Institute of Zoology, Chinese Academy of Sciences (KIZ), and China West Normal University (CWNU).

## 3. Results

***Japalura vela* sp. nov. Wang, Jiang, Che** (Figures 1–6)

### Synonymies

*Japalura yunnanensis* Vogt, 1924: 338

*Japalura flaviceps* Hu *et al.*, 1987: 112

*Japalura flaviceps* Pope, 1935: 467

*Japalura flaviceps* Zhao and Jiang, 1977: 293–298

*Japalura flaviceps* Zhao *et al.*, 1999: 111–115

*Japalura flaviceps* Li *et al.*, 2010: 115

*Japalura* sp. A Manthey *et al.*, 2012

**Holotype** KIZ013801 (Figures 1–4, 6), adult male from Quzika of Markam, eastern Tibet, PR China (29°5' N, 98°36' E), at elevation of 2370 m, collected by Ke JIANG and Kai WANG on May 23<sup>rd</sup>, 2013.

**Paratypes** Two adult females (KIZ013802 and KIZ013813) and eight adult males (KIZ013800 and KIZ013805–013811) all share the same data as the holotype, collected by Ke JIANG, Kai WANG, and

Duan YOU.

**Diagnosis** Following Inger's (1960) definition of the genus, the new species is assigned to *Japalura* based on a number of diagnostic characters, including: 1) dorsal scales unequal in size, 2) presence of enlarged crest scales, 3) presence of gular sac, 4) presence of lateral fold of skin in axilla–groin region, 5) supraciliary scales greatly imbricate; 6) head relatively long, flat; 7) tail long, slender; 8) tail cylindrical in shape; and 9) absence of precloacal or femoral pores.

The new species differs from all known congeners by the following combination of characters: 1) small adult size (SVL 56–69 mm in males, 59–66 mm in females); 2) moderate tail length (TAL/SVL 1.92–2.06 in males, 1.85–1.86 in females); 3) moderate hind limb length (HLL/SVL 0.72–0.81); 4) T4S 24 or 25; 5) tympanum concealed; 6) transverse gular fold present; 7) gular pouch present; 8) axillary folds present; 9) males with pronounced, continuous, sail-like vertebral crest along entire length of body from posterior margin of head to base of tail; 10) ground body coloration black in males, medium to dark brown in females; 11) white coloration on ventral surface of body in males; 12) presence of white transverse streaks on dorsal head; 13) presence of black radiated streaks around eyes; 14) ventral surface of head with prominent black vermiculate stripes; 15) gular spots absent; 16) presence of distinct, jagged, yellowish-white dorsolateral stripes in males; and 17) presence of faint, reddish, dorsolateral lines restricted to anterior half of axilla–groin region in females.

**Description of holotype** Adult male, SVL 69 mm, TAL 136 mm, HL 20.8 mm, HW 14.5 mm, FLL 31.2 mm, HLL 50.8 mm, T4L 13.2 mm, TRL 33.0 mm. Rostral rectangular, four times longer than height, in contact with nine scales including supralabials; nasal sub-rectangular, separated from rostral by two small scales; supralabials nine on both sides of head, weakly keeled, first supralabial separated from nasal by single small scale; scales in loreal region irregularly arranged; small ciliaries around eyes, separated from SL by three rows of scales; supraorbital ridge with single row of elongated, strongly keeled, imbricate canthals and supraciliaries; scales posterior to orbit greatly enlarged compared to loreals, strongly keeled; tympanum concealed, covered with small scales.

Scales on dorsal surface of head heterogeneous in size, strongly keeled, forming “Y”-shaped ridge from postrostral to posterior edge of orbit. Mental pentagonal; infralabials 10 on both sides of head, lacking keels; scales on ventral surface of head homogeneous in size, keel protuberance increasing posteriorly towards throat;

transverse gular fold present; gular pouch present; scales covered by gular fold smaller than those on ventral surface of head; shoulder fold posterior to gular fold on each side of body.

Middorsal scales serrated, consisting of 46 relatively large scales; in life, males with pronounced, sail-like, continuous vertebral crest along entire length of body from posterior margin of head to base of tail; in preservation, crest reduced in protuberance; dorsolateral ridge composed of large, strongly keeled

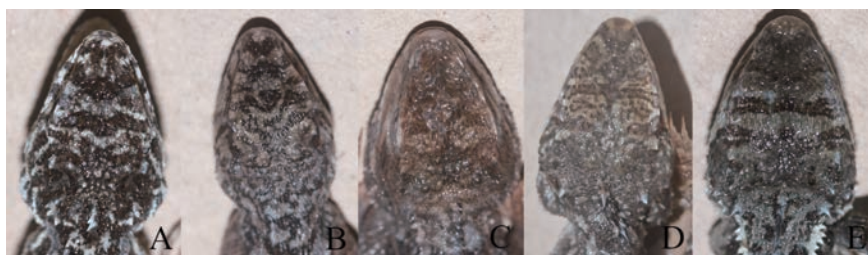


**Figure 1** Dorsolateral close-ups, dorsolateral overviews, and ventral overviews of *Japalura vela* sp. nov.: The male holotype KIZ013801 (A, B, and C) and the female paratype KIZ013802 (D, E, and F) in life. Images not to scale. Photos by Kai WANG.



**Figure 2** Dorsal (left) and ventral (right) views of holotype (KIZ013801) of *Japalura vela* sp. nov. in preservative. Photo by Kai WANG.

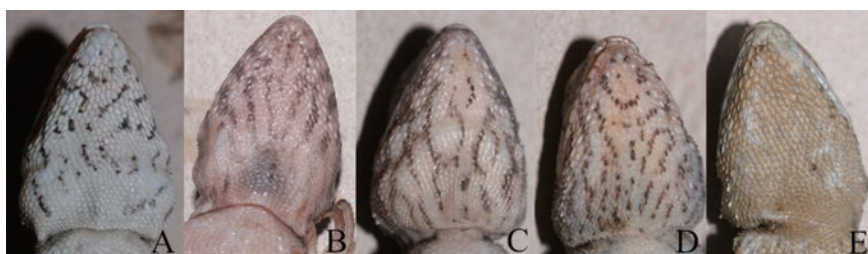




**Figure 3** Dorsal head views of males of *Japalura vela* sp. nov. holotype KIZ013801 (A) and *J. batangensis* CIB1902 (B), *J. flaviceps* CIB2333 (C), *J. zhaoermii* CIB85722 (D), and *J. micangshanensis* CIB2572 (E) in preservative. Images not to scale. Photos by Ke JIANG.



**Figure 4** Ventral head views of males of *Japalura vela* sp. nov. holotype KIZ013801 (A) and paratype KIZ013805 (B), *J. batangensis* CIB1902 (C), *J. flaviceps* CIB2333 (D), *J. zhaoermii* CIB85722 (E), and *J. micangshanensis* CIB2572 (F) in preservative. Images not to scale. Photos by Ke JIANG and Kai WANG.



**Figure 5** Ventral head views of females of *Japalura vela* sp. nov. paratype KIZ013802 (A), *J. batangensis* CIB1908 (B), *J. flaviceps* CIB2234 (C), *J. zhaoermii* CIB86432 (D), and *J. micangshanensis* CIB86356 (E) in preservative. Photos by Ke JIANG.



**Figure 6** Dorsal views of males of *Japalura vela* sp. nov. holotype KIZ013801 (A), *J. flaviceps* KIZ05181 (B), and *J. batangensis* CIB2233 (C) in preservative. Photos by Ke JIANG and Kai WANG.

scales continuous along length of body, centered along dorsolateral stripes on each side; dorsal ground scales small, slightly keeled, randomly distributed; lateral

ground scales similar to dorsal ground scales in size, shape, keel protuberance, distribution; large, distinctively keeled scales scattered among ground scales on dorsal

and lateral surfaces of body.

Scales on ventral surface homogeneous in size, greatly keeled compared to dorsal ones. Limb scales more or less homogeneous in size, keeled, more pronounced on ventral surface; Toe IV subdigital lamellae 24. Tail scales homogeneous in size, strongly keeled, keels align in longitudinal rows along entire length of tail.

**Coloration of holotype** The dorsal surface of the head is black with three distinct, narrow, ash gray transverse streaks, one in a “m”-shape between the nares, and two in a “X”-shape between the eyes. The lateral surface of the head is white with nine or ten black streaks radiating around each eye. Four of these streaks are observed below the eyes on both sides of the head, and extend to the supralabial scales, with the posteriormost streak being the broadest. The infralabial scales have short black bars that are aligned with streaks on the supralabials. Pigmentation on the chin and throat is white with distinct black vermiculate stripes angled medially towards the midline of the body. Dorsal and lateral surfaces of the body are black, but gradually fade to brownish black from the base of the tail to its tip, as well as from the proximal to the distal end of the limbs. Prior to capture, the individual possessed a strongly jagged yellow dorsolateral stripe on each side of the vertebral crest along the length of the body. Following capture, the coloration of the two stripes changed to yellowish brown. Seven narrow yellow bands are present across the dorsal surface of the body from the neck to the groin. Posterior bands 3–7 extend across the dorsolateral stripes on both sides of the body. Lateral surface of the body in the axilla–groin region possesses irregularly distributed, small to moderate-sized, yellow spots. The larger lateral yellow spots nearly form two longitudinal rows. The dorsal surface of the tail is brownish black with 16 light-gray, transverse bands evenly distributed along the length of the tail. Coloration of the dorsal surfaces of limbs consists of a brownish black ground color with white transverse bands running along their length. The ventral surfaces of the body and limbs are uniformly white, except the palms and soles, which are yellowish-white (Figure 1).

Although the coloration of the holotype in preservation closely matches its coloration in life, the following differences were observed: 1) dorsolateral stripes are dark gray, 2) transverse bands on the dorsal surface of the body and spots on lateral surface of the body are white, and 3) dorsal surface of the tail is dark gray (Figure 2).

**Variation** Variation in morphometric and meristic characters is summarized in Table 1. Additionally, the following coloration differences exist in the male

paratypes: 1) three male paratypes (KIZ013805, 013806, and 013809) have significantly faded bluish coloration on the gular pouches, but nevertheless the faded color does not form clear gular spots (Figure 4); 2) several dorsal transverse bands do not extend completely across the dorsal midline in three males (KIZ013808–10); and 3) the vertebral skin fold of one male (KIZ 013800) is less developed than the holotype.

Sexual dimorphism is observed for a number of characters. Females have more vertically compressed bodies (*vs.* less compressed), shorter tails (ratio of TAL/SVL 1.85–1.86 *vs.*  $\geq 1.92$ ), highly reduced vertebral crests (*vs.* pronounced and sail-like), brown ground coloration on the dorsal and lateral surfaces of the body (*vs.* black), a greater number of keeled, paravertebral scale rows on dorsal and lateral surfaces of body (four *vs.* two), and a faint, reddish dorsolateral lines restricted to anterior half of axilla–groin region (*vs.* a distinct yellow stripes along the entire length of the body). Additionally, females possess chevron-shaped brown pigmentation blotches along the dorsal midline of the body (*vs.* absent), and white, dorsal, transverse bands that extend across the lateral portions of the body (*vs.* extension just past the dorsolateral stripes; Figure 1). Overall, the juveniles (KIZ013799, 013804, 013812) resemble the adult females, but they differ by having granular scales on the dorsal and lateral surfaces of the head, broader, white transverse bands on the dorsal surface of body, and by the absence of unclear reddish dorsolateral lines.

**Comparisons** *Japalura vela* sp. nov. was previously recognized as *J. flaviceps* (Hu *et al.*, 1987; Li *et al.*, 2010; Zhao and Jiang, 1977), but it can be distinguished easily from the latter by having a greater number of T4S (24 or 25 *vs.* 21–23), a smaller adult body size (maximum SVL up to 69mm *vs.* to 83mm), a relatively shorter snout (ratio of SEL/HL 0.33–0.38 *vs.* 0.39–0.44), a pronounced, sail-like, and continuous vertebral crest in males (*vs.* weak or discontinuous with a clear break in the skin fold between the nuchal and dorsal regions of the body), a black dorsal background coloration in males (*vs.* brownish gray), black (in males) or brown (in females) rectangular patches on the dorsal surface of the body along the midline (*vs.* a lateral series of dark brown rhombs with yellow centers), as well as by the presence of multiple distinct transverse streaks on the dorsal surface of the head (*vs.* absent, significantly faded, or in low numbers), and the presence of distinct radiated streaks around the eyes (*vs.* absent).

The new species is morphologically most similar to *J. batangensis*, *J. micangshanensis*, *J. zhaoermii*, and *J. variegata* in external morphology, with all five species

**Table 1** Morphometric characters and meristic data of the type series of *Japalura vela* sp. nov.

| Number    | Status   | Sex    | SVL   | TAL     | TAL/SVL   | HL        | HL/SVL    | HW        | HW/SVL    | SEL     | IOD     | FLL       | FLL/SVL   | HLL       | HLL/SVL   | T4L       | TRL       | SL   | IL    | NSL  | MD    | T4S   | SOR    | SCL  |
|-----------|----------|--------|-------|---------|-----------|-----------|-----------|-----------|-----------|---------|---------|-----------|-----------|-----------|-----------|-----------|-----------|------|-------|------|-------|-------|--------|------|
| KIZ013801 | holotype | male   | 69    | 136     | 1.97      | 20.8      | 0.3       | 14.5      | 0.21      | 7.4     | 9.5     | 31.2      | 0.45      | 50.8      | 0.74      | 13.2      | 33.0      | 9/9  | 10/10 | 1/1  | 46    | 25/25 | 3/3    | 7/7  |
| KIZ013809 | paratype | male   | 60    | 115     | 1.92      | 18        | 0.3       | 12.8      | 0.21      | 6.4     | 8.7     | 28.4      | 0.47      | 44.9      | 0.75      | 11.3      | 25.3      | 8/8  | 10/11 | 1/1  | 42    | 24/25 | 3/3    | 7/7  |
| KIZ013808 | paratype | male   | 65    | 134     | 2.06      | 19.5      | 0.3       | 14        | 0.22      | 6.9     | 9.6     | 31.5      | 0.49      | 50.3      | 0.77      | 12.3      | 31.3      | 8/8  | 9/10  | 2/2  | 47    | 24/25 | 3/3    | 7/7  |
| KIZ013805 | paratype | male   | 62    | 122     | 1.97      | 18.7      | 0.3       | 13.5      | 0.22      | 6.8     | 9.3     | 29.9      | 0.48      | 50.1      | 0.81      | 12.0      | 29.4      | 8/8  | 11/11 | 2/1  | 41    | 24/24 | 3/3    | 7/7  |
| KIZ013800 | paratype | male   | 60    | 123     | 2.05      | 18.8      | 0.31      | 13        | 0.22      | 7       | 9.2     | 28.6      | 0.48      | 43.9      | 0.73      | 11.9      | 29.0      | 9/10 | 11/10 | 1/2  | 44    | 25/25 | 4/4    | 7/7  |
| KIZ013807 | paratype | male   | 56    | 110     | 1.96      | 17.3      | 0.31      | 12.2      | 0.22      | 6.5     | 8.4     | 28.0      | 0.50      | 44.0      | 0.79      | 11.3      | 26.0      | 9/9  | 10/10 | 1/1  | 44    | 24/24 | 3/3    | 7/7  |
| KIZ013806 | paratype | male   | 65    | 129     | 1.98      | 20        | 0.31      | 13.6      | 0.21      | 7.4     | 9.6     | 31.5      | 0.48      | 46.6      | 0.72      | 12.6      | 29.7      | 9/10 | 10/10 | 1/1  | 44    | 25/24 | 3/3    | 7/7  |
| KIZ013811 | paratype | male   | 64    | 127     | 1.98      | 19.9      | 0.31      | 14.1      | 0.22      | 6.9     | 9.2     | 29.3      | 0.46      | 45.8      | 0.72      | 13.1      | 28.6      | 7/8  | 9/9   | 1/2  | 44    | 24/25 | 3/3    | 7/7  |
| KIZ013810 | paratype | male   | 57    | 112     | 1.96      | 19.2      | 0.34      | 13.9      | 0.24      | 6.4     | 9       | 25.5      | 0.45      | 44.7      | 0.78      | 11.9      | 26.3      | 9/9  | 11/11 | 2/2  | 45    | 24/24 | 4/4    | 7/7  |
| Range     |          |        | 56–69 | 110–136 | 1.92–2.06 | 17.3–20.8 | 0.30–0.34 | 12.2–14.5 | 0.21–0.24 | 6.4–7.4 | 8.4–9.6 | 25.5–31.5 | 0.45–0.50 | 43.9–50.8 | 0.72–0.81 | 11.3–13.2 | 25.3–33.0 | 7–10 | 9–11  | 1–2  | 41–47 | 24–25 | 3 or 4 | 7    |
| Average   |          |        | 62    | 123     | 1.98      | 19.1      | 0.31      | 13.5      | 0.22      | 6.9     | 9.2     | 29.2      | 0.47      | 46.9      | 0.76      | 12.2      | 28.8      | 8.61 | 10.17 | 1.39 | 44.1  | 24.4  | 3.22   | 7    |
| KIZ013802 | paratype | female | 66    | 123     | 1.86      | 19.5      | 0.3       | 14        | 0.21      | 7.4     | 9.1     | 32.0      | 0.48      | 47.9      | 0.73      | 13.9      | 32.7      | 9/9  | 11/10 | 2/2  | 51    | 24/24 | 3/3    | 8/8  |
| KIZ013813 | paratype | female | 59    | 109     | 1.85      | 17.3      | 0.29      | 12.4      | 0.21      | 6.2     | 8.8     | 28.0      | 0.47      | 43.1      | 0.73      | 12.1      | 30.2      | 9/9  | 10/11 | 2/1  | 47    | 25/25 | 3/3    | 7/8  |
| Average   |          |        | 63    | 116     | 1.86      | 18.4      | 0.3       | 13.2      | 0.21      | 6.8     | 9       | 30.0      | 0.48      | 45.5      | 0.73      | 13.0      | 31.5      | 9    | 10.5  | 1.75 | 49    | 24.5  | 3      | 7.33 |

Measurements of SVL, TAL, HL, HW, T4L, TRL, FLL, and HLL are in the unit of millimeter (mm), all meristic data are given in decimals, and paired meristic characters are all given in left/right order. For average calculation of paired measurements, each one of the paired measurements is treated independently. Full terms of abbreviations are shown in the method section.

having transverse streaks on the dorsal surface of the head, distinct radiated streaks around the eyes, pronounced vertebral crest in males, and dorsolateral stripes that run parallel to the dorsal midline in males. However, males of the new species can be distinguished from males of the latter four species by having a pronounced, sail-like, continuous vertebral crest running along the entire length of the body, with no distinct break between the nuchal and dorsal sections (vs. discontinuous or having a clear break between the two sections). Additionally, the new species differs from *J. batangensis* by having a greater number of T4S (24 or 25 vs. 18–22), a tendency towards longer hind limbs (ratio of HLL/SVL 0.72–0.81 vs. 0.65–0.75), a white coloration on ventral surface of body in males (vs. bright yellow), as well as by the presence of unclear reddish lines dorsolaterally in females (vs. absent or presence of distinct dorsolateral stripes), and the absence of a distinct gular spot (vs. always present in males, often in females, greenish blue); from *J. micangshanensis* by having a black dorsal background coloration in males (vs. brownish), as well as by the presence of a gular fold (vs. absent), the presence of distinct black vermiculate stripes on the ventral surface of the head (vs. absent), and by the presence of unclear reddish lines dorsolaterally in females in life (vs. absent); from *J. zhaoermii* by having a smaller adult body sizes (maximum SVL up to 69 mm vs. to 85 mm), as well as by the absence of a gular spot (vs. present in males, yellowish green), and the presence of distinct, narrow, black vermiculate stripes on ventral surface of heads in males (vs. indistinct, broad stripes that fade significantly towards the center of the gular pouch); and from *J. variegata* by having fewer MD (41–51 vs. 54–67), a black dorsal background coloration (vs. olive green), as well as by the absence of black reticulated patterns on the lateral surface of the body (vs. present), and by the absence of a gular spot (vs. present, violet).

*Japalura vela* sp. nov. can also be distinguished from the congeners that distribute along the same river or in close proximity. The new species can be distinguished from *J. yunnanensis*, which occupies the lower reaches of Lancang River, by having a shorter tail (ratio of TAL/SVL  $\leq 2.06$  vs.  $\geq 2.25$ ), one or two scales between nasal and the first SL (vs. in direct contact), a black ground coloration of the dorsal surface of the body in males (vs. brown or olive green), as well as by the absence of a distinct gular spot in males (vs. present in males, light yellow), and the presence of prominent black vermiculate stripes on the ventral surface of the head (vs. absent). For species from adjacent areas, the new species differs from *J. brevicauda* by having a longer tail (ratio of TAL/SVL



$\geq 1.85$  vs.  $\leq 1.45$ ), longer fore-limbs (ratio of FLL/SVL  $\geq 0.45$  vs.  $\leq 0.40$ ), longer hind limbs (ratio of HLL/SVL  $\geq 0.72$  vs.  $\leq 0.64$ ), greater number of T4S (24 or 25 vs. 16–20), as well as by the presence of a distinct gular pouch (vs. not visible); and from *J. yulongensis* by having a shorter tail (ratio of TAL/SVL ratio  $< 2.06$  vs.  $> 2.23$ ), as well as by the absence of a distinct gular spot in preserved male specimens (vs. present, dark in preservation).

The new species *J. vela* sp. nov. can be easily distinguished from the remaining mainland congeners by having distinct ornamentations and obvious morphological characteristics without detailed comparisons of pholidosis. The new species differs from *J. andersoniana* by having shorter hind limbs (ratio of HLL/SVL 0.72–0.81 vs. 0.88–1.10); from *J. fasciata* by the absence of pale-blue, hourglass-shaped pattern on mid body (vs. present); from *J. grahami* by having a greater number of MD (41–45 vs. 10); from *J. otai* Mahony, 2009, *J. sagittifera* Smith, 1940, and *J. planidorsata* Jerdon, 1870 by having a un-depressed body shape (vs. vertically depressed), as well as by the presence of two distinct, broad dorsolateral stripes in males (vs. absence or distinctively narrow), and the absence of a light vertebral strip on the dorsal surface of the body (vs. present); from *J. dasi*, *J. dymondi*, *J. kumaonensis*, *J. tricarinata* (Blyth, 1854), and *J. varcoae* by having a concealed tympanum (vs. exposed); from *J. major* (Jerdon, 1870) by having a concealed tympanum (vs. mostly exposed), a black ground coloration with white spots on the lateral surface of the body in males (vs. olive ground color, reticulated with black on the lateral sides), a uniform white coloration on ventral surface of the body (vs. speckled with black), as well as by the absence of white lip-stripes below the eyes (vs. present); from *J. splendida* by having a smaller adult body size (maximum SVL  $< 69$  mm vs.  $< 92$  mm), jagged dorsolateral stripes in males (vs. with smooth edges), a black (males) or brown (females) ground coloration of the dorsal surface of the body (vs. gray or green), as well as by the presence of pronounced, continuous, sail-like vertebral crest in males (vs. feebly developed and discontinuous); from *J. hamptoni* Smith, 1935 by having parallel, strongly jagged dorsolateral stripes in males (vs. diagonally away from the dorsal midline and with smooth edges); and from *J. chapaensis* Bourret, 1937 by having fewer T4S (24 to 25 vs. 28), a light-pink coloration of the oval cavity in life (vs. yellow), as well as by the absence of distinct gular spot (vs. present in males, yellow), and the absence of reticulated black pigmentation on the lateral surface of the body (vs. present).

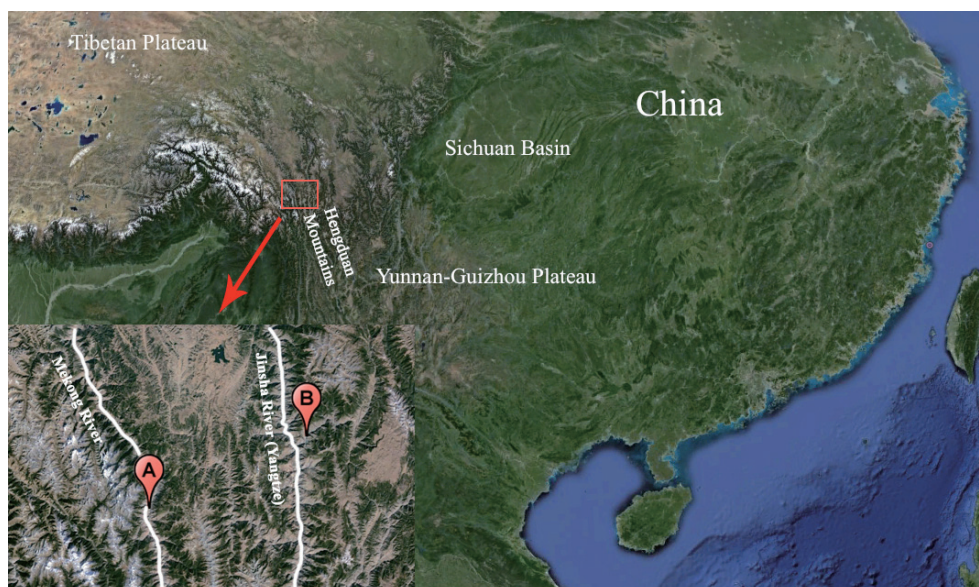
Additionally, the new species differs from all island

species (*J. breviceps* Gressitt, 1936; *J. luei* Ota, Chen and Shang, 1998; *J. makii* Ota, 1989; *J. polygonata polygonata* (Hallowell, 1860); *J. polygonata donan* Ota, 2003; *J. polygonata ishigakiensis* Van Denburgh, 1912; *J. polygonata xanthostoma* Ota, 1991; and *J. swinhonis* Günther, 1864) by having a transverse gular fold (vs. absent), a black ground coloration of the dorsal surface of the body in males (vs. brown or green), the parallel dorsolateral stripes (vs. absent or diagonally away from dorsal midline), and a terrestrial lifestyle (vs. arboreal), as well as by the absence of a distinct gular spot in males (vs. present).

**Distribution and Ecology** The new species is currently known only from the type locality (Figures 7–8), but it may be found in valleys of adjacent reaches along Lancang Rivers. As a terrestrial species, individuals were observed commonly in rocky areas or steppe-shrub habitat along the arid river valley (Figure 7). Adult males usually basked on high rocks, while adult females and juveniles stayed lower in the rock piles, suggesting possible niche



**Figure 7** The microhabitat (A) and macrohabitat (B) of *Japalura vela* sp. nov. at the type locality, Quzika, Tibet. Photos by Duan YOU.



**Figure 8** Map showing the relative positions of the type locality of *Japalura vela* sp. nov. (A) and *J. batangensis* (B) in PR China.

partitioning among different age-groups and between different sexes. Males are territorial, in which the territory holder will perform vertical head-nodding movements and display gular pouch toward the invader, and physical contacts (biting and chasing) will happen if the invader refuses to leave. No territorial behaviors were seen among females or juveniles. Possible predations may come from snakes (Chinese Beauty Snake, *Orthriophis taeniurus*, KIZ013803, was collected from the same locality) and large birds (*Corvus* sp., also commonly observed at this locality).

**Etymology** The Latin word *vela* means “sail”, which describes the shape of the pronounced and continuous vertebral crest as the diagnostic morphology of the males of the new species. Hence according to the Latin name, we suggest Sail Mountain Lizards or Sail Japalura as its English common name, and Fan Bei Pan Xi (帆背攀蜥) as its Chinese common name.

#### 4. Discussion

Previous studies have suggested that *Japalura* lizards show a strong tendency to distribute along river valleys in the Hengduan Mountains, where each species is endemic to specific reaches of the river (Manthey *et al.*, 2012; Yang and Rao, 1992). For example, along the Yangtze River, *J. batangensis* is endemic to the very upper reaches of Jinsha River (Li *et al.*, 2001; Wu *et al.*, 2005); *J. yulongensis* and *J. brevicauda* have been found in slightly lower reaches in northwestern Yunnan only (Manthey *et al.*, 2012); *J. dymondi* has been reported in further lower

reaches of north central Yunnan and southern Sichuan (Yang and Rao, 2008; Zhao *et al.*, 1999); and *J. splendida* has been found in the rest of the middle reaches of Yangtze River (Manthey *et al.*, 2012; Zhao *et al.*, 1999). For the Lancang River, *J. yunnanensis* was reported to occur in the lower reaches in southwestern Yunnan (Jiang, 1992; Yang and Rao, 2008; Zhao *et al.*, 1999), and *J. vela* appears to be distributed along the upper reaches of the Lancang River in Tibet. This continuous distribution pattern of species in the genus along the Lancang River is consistent with the river-based distribution pattern of other mainland congeners in East Asia. Given the large number of un-surveyed river habitats and additional unexamined records *J. cf. flaviceps* in Yunnan Province (Pan *et al.*, 2002; Yang and Rao, 2008), there may still be undiscovered species diversity in the valleys of the upper Lancang River Basin and adjacent areas.

The rise of the Hengduan Mountains have been shown to have created geographic barriers to formerly continuous populations of species within the herpetofauna, which resulted in population diversification and, subsequently, speciation (Che *et al.*, 2010; Huang *et al.*, 2009; Yang *et al.* 1987). For the genus *Japalura*, *J. vela* and *J. batangensis* occur in close proximity (about 60 km between their native valleys), and yet the two river valleys are separated by continuous mountains reaching over 3 500 m in elevation (Figure 8). Given that the known upper distribution limit of *Japalura* in the area is 3 000 m in elevation only (Yang *et al.*, 1987), we believe these two species to be allopatrically distributed. Much work remains to be done with this genus, including



studies on sexually dimorphic traits, crest evolution, and biogeographic patterns. Future phylogeographic and behavioral studies are needed to gain a better understanding of their unique evolutionary history.

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#### Appendix 1 Specimens examined.

- Japalura batangensis* (n=19): CWN98012 (holotype), CWN98004, 98010, 98014–18, CIB2227, 2233, 2243, 1902–09, Batang, Sichuan, China.
- J. dymondi* (n=3): CIB87234, 1869, 1817, Panzhuhua, Sichuan, China.
- J. flaviceps* (n=10): CIB2332, 2341, 2354, 2355, 2333, 2234, 2561, 2556, Luding, Sichuan, China; KIZ05181–05182, Luding, Sichuan, China.
- J. grahami* (n=1): USMN65500 (holotype), Yibin, Sichuan, China.
- J. micangshanensis* (n=9): CIB86351, 86348, Xianyang, Shanxi, China; CIB86360, 86361, 86356, 86357, Luonan, Shanxi, China; CIB2572, 2578, 2582, Wenxian, Gansu, China.
- J. splendida* (n=6): USNM 35522 (holotype), Yichang, Hubei, China; CIB2588, 2591, 2596, Wushan, Chongqing, China; CIB72468, 72469, Yunyang, Chongqing, China.
- J. varcoae*: (n=2): CIB2651, 2650, Kunming, Yunnan, China.
- J. yunnanensis* (n=4): CIB2686, 2687, 2689, 2684, Longling, Yunnan, China.
- J. zhaoermii* (n=8): CIB002690 (holotype), CIB86435, 86432, 85722, 85721, Wenchuan, Sichuan, China; CIB2232, 2244, 2240, Lixian, Sichuan, China.